REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
15-12-2011	Final	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
10-2-176 Condensation Testing - Shelters

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 10-2-176

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A. Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.:

14. ABSTRACT
This TOP describes procedures for testing 15-man and smaller lightweight expedient shelter systems for condensation build-up or mitigation and reports results in a quantifiable manner.

15. SUBJECT TERMS
soft wall shelters   condensation

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**B. ABSTRACT**	**C. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	SAR	24	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 10-2-176 — 15 December 2011
DTIC AD No.

CONDENSATION TESTING - SHELTERS

*Approved for public release; distribution unlimited.

1. BACKGROUND.

a. During military deployments and missions in remote environments, Warfighters seek refuge from cold, hot, and/or wet conditions by the means of lightweight, potentially back-packable combat shelter systems. The shelter interior must be dry and comfortable, while protecting the Warfighter from environmental intrusion through the use of waterproof barrier materials. Certain shelter system designs have adopted the use of breathable/waterproof materials that allow air exchange and moisture diffusion out of the shelter interior. Other more traditional designs incorporate a double wall design that provides significant breathability through the first layer, but then employs a completely waterproof non-breathable material for the second layer (or rain fly). Regardless of the design, almost every shelter system may be susceptible to condensation build-up when deployed in cold environments.

b. Condensation is most often seen on the interior shelter walls, and can become so severe that the “rolling” of coalescing water drops down the walls and may begin to pool and soak into the Warfighter’s sleeping bag and clothing. This wetness will directly affect the quality and quantity of rest that the Warfighter is receiving, in turn, potentially reducing his/her mission effectiveness the following day.

c. Condensate forms when the interior shelter skin temperature is below the dew point indicated by the interior conditions. In cold climates, it is frequently the case that the shelter skin is significantly lower in temperature than the dew point of the interior conditions. If a shelter design were to include insulation, or appropriate venting, a large amount of the exhaled moisture would either not form condensate, due to absorption and permeation or be vented through physical openings to the exterior of the shelter system.

2. SCOPE.

a. This Test Operations Procedure (TOP) provides test methodology for determining and quantifying the condensation mitigation or build-up within 15-man or smaller combat shelter systems as specified in requirements documentation. It does not cover special shelter testing such as rain penetration, durability, blackout, sound level, ventilation, etc., governed by separate TOPs. This document does not impose design specifications; rather, it describes tailored processes that result in realistic test methods based on materiel system performance requirements. The focus pertains only to those levels of testing appropriate for military shelter systems and considers test levels neither too high nor too low but based on the environments that the shelter systems will be deployed in throughout their service life.

b. Shelter systems to be considered for this test are back-packable tactical shelters, arctic combat shelters, and bivouac shelter systems. These lightweight shelter systems are highly expedient structures designed to enable Warfighter mission readiness, provide protection from environmental elements and insects, camouflage against the enemy, and/or provide privacy.

c. These shelter systems may be one of several different design variants. Some designs may incorporate a non-permeable exterior rain fly over a breathable interior fabric, while others may only use a water proof/breathable barrier fabric to create a single wall design. The incumbent arctic shelter system uses water wicking cotton materials that are highly breathable.

d. It is the scope of this test standard to evaluate shelter systems of the 15-man or smaller size variant, regardless of design or material selection, for condensation mitigation or build-up, by the means of a procedure that is both repeatable and absolute without relative comparisons.

e. Not applicable for shelters with active heating or cooling as these contribute to perceived drying of the shelter.

f. Test procedure was designed to facilitate a method by which condensation could be quantified in a fully occupied shelter system. Shelter shall be considered occupied to the limits as specified by the manufacturer.

g. Test procedure is not designed to quantify or study the effects of frost build-up within the shelter interior, during extreme cold climate deployments.

h. Test procedure does not propose controlling the shelter interior conditions; instead it intends to evaluate the change in interior shelter conditions given a known quantity of water vapor and heat input.

3. FACILITIES, TEST EQUIPMENT AND INSTRUMENTATION.

3.1 Facilities.

The Environmental Test Facility climatic chamber that is necessary to conduct simulated environmental testing shall:

a. Be capable of achieving and maintaining 40 ºFahrenheit (ºF) at 80% relative humidity (RH) as indicated in this test procedure.

b. Be capable of controlling relative humidity levels to a tolerance of ± 5% (as per Military Standard (MIL-STD) 810G[1]*.

c. Be capable of controlling temperature levels to a tolerance of ± 3.6 ºF (as per MIL-STD-810G).

d. Be capable of maintaining controlled humidity and temperature levels at wind speeds lower than 3.5 miles per hour (mph). Some level of wind is often necessary for proper "mixing" of climatic chamber conditions.

e. Be capable or controlling wind speed to a tolerance of ± 0.5 mph.

* Superscript numbers correspond to Appendix C, References.

f. Have sufficient floor and vertical space to deploy the largest shelter to be tested with at least 1 foot distance between any shelter exterior surface and any climatic chamber interior surface.

g. Have at least two (2) 110 volt (V) power outlets each with 20 amp maximum load breakers per tent being tested at the same time.

h. Have sufficient ambient lighting to perform test setup and tear down.

i. Have sufficient temporary lighting in place to view the interior of the shelter skin upon test completion.

j. Have a suitable area upon which data acquisition equipment may be placed and simultaneously viewed without affecting the chamber interior conditions.

3.2 Equipment.

a. The test equipment is composed of a variable heat output water vaporization plate, a means by which to introduce water onto the plate at a controllable flow rate, and supplemental heating to provide the remaining heat output necessary to simulate the respective number of occupants. Figure 1 illustrates some of the commercial variants that may be used to provide the equipment functionality.

Figure 1. Typical condensation testing set-up.

b. Figure 2 and Table 1 illustrate the functional elements, or items, required for the testing apparatus to function and provide simulated water vapor and heat output. Figure 2 is a graphical schematic depicting the interconnectivity and arrangement of all necessary items.

Table 1 indicates commercial variants to the elements described in Figure 2, and information regarding their procurement.

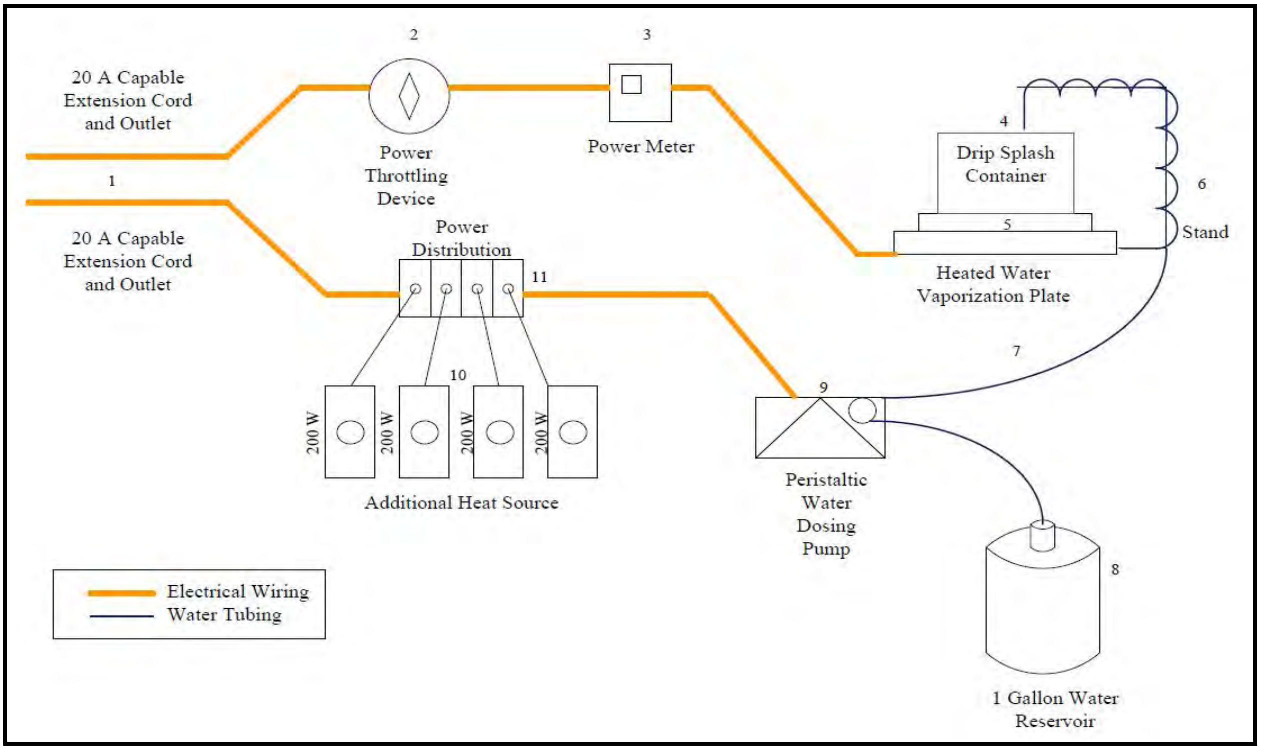

Figure 2. Schematic depicting the interconnectivity and arrangement of necessary items

TABLE 1. EQUIPMENT LISTING

NUMBER	QUANTITY	ITEM	COMMERCIAL VARIANT
1	4	Power cables	Extension cords
2	1	Power throttling device	VARIAC (voltage adjust)
3	1	Power meter	Kill-A-Watt residential power meter
4	1	Drip/splash containment	Stainless Steel Beaker (diameter = hot plate heated surface)
5	1	Heated water vaporization plate	1500 watt (W) table range
6	1	Stand	Chemistry lab grade stand
7	6 feet	Tubing	1/8 inch inside diameter (ID) tubing
8	1	Water reservoir, 1 gallon	Polyethylene terephthalate (PET) container, 1 gallon
9	1	Water dosing pump	Calibrated peristaltic pump
10	4	Additional heat source	200 W heaters
11	1	Power distribution	Electrical power strip
Not applicable	1	Fire proof platform	Stainless steel sheet metal

3.3 Instrumentation.

3.3.1 Calibration.

All instruments used to monitor or control test parameters must be calibrated for accuracy. Generally, instruments should be checked prior to and after each test. Calibration intervals must meet the guidelines of American National Standards Institute (ANSI)/National Conference of Standards Laboratories (NCSL) Z540.3[2] or International Organization for Standardization (ISO) 10012[3]. All instruments and test equipment used in conducting the tests in this document must:

a. Be calibrated to laboratory standards, and be traceable to National Institute of Standards and Technology (NIST) standards.

b. Have accuracy equal to at least one-third the tolerance of the variable to be measured. In the event of conflict between this accuracy and guidelines for accuracy in the test methods of this TOP, the TOP governs.

3.3.2 Instruments.

Instrument	Error
Relative humidity sensor	± 3%
Thermocouple sensor temperature	± 1 ºF
Total elapsed time	± 1% of specified value

Instrument	Requirement
Power Meter	± 10 Watts

4. PRETEST CONSIDERATIONS.

a. The shelter system to be tested shall not have been subjected to any prior operational use. Any destructive testing (ultraviolet (UV), snow load, high temperature, etc…) shall be performed following this test. In the event that several shelters are tested for the sake of relative performance comparison, the order in which the respective shelters undergo testing shall remain consistent.

b. The objective of this test is to evaluate an unused shelter system for condensation build-up or mitigation, not the ability of a shelter system to perform well in a condensation prone environment after being used for an extended period of time or having been exposed to weather elements.

5. TEST PROCEDURES.

One or more shelters may be tested simultaneously, only if the test equipment and resources are available, as well as the test chamber floor space is sufficiently large to support multiple test items.

5.1 Initial Inspection.

The purpose of this test is to determine if the test item(s) is/are complete and ready for testing. The shelter system should be erected or set up in accordance with the Operator's Technical Manual (TM). The TM is normally supplied with the test item. If possible, set up the test item under standard ambient conditions to ensure that it is operating properly and to obtain baseline performance and background data.

a. Background data of each item:

(1) Item number, nomenclature, model, serial number, and manufacturer as indicated in Table 2.

(2) Inventory of major components. Use equipment list (Table 2) if an inventory list is not provided.

(3) Environmental test history of the test item. Determine if the test item has been tested before.

TABLE 2. TEST ITEM INVENTORY LIST

Test Project No_________________________________ Item No._________________

ITEM NO.	NOMENCLATURE	MODEL/SERIAL NO.	QUANTITY	PHYSICAL APPEARANCE

b. Visually inspect the shipping package(s) and test item(s), and record the following:

(1) Any damage to the shipping package(s).

(2) Any damage to the test item or its accessory equipment including:

(a) Test item tears, broken accessories.

(b) Test item material deterioration.

(c) Manufacturing defects.

(d) Evidence and effects of moisture, spillage, mildew, mold, or insect attack.

(e) Evidence of wear.

c. Compare the items received to the item inventory list. Record any shortages, such as:

(1) Missing accessories.

(2) Missing tools.

(3) Missing instructions.

(4) Missing components.

d. Photograph the following:

(1) All components.

(2) Fully deployed shelter.

(3) Evidence of damage.

(4) Manufacturer's labels and instructions (safety (cautions, warnings, lifting), operating, maintenance, etc.) attached to the test item.

5.2 Safety and Health.

The purpose of this test is to determine any safety or health hazards associated with the test item. Safety assessment will focus on obvious hazards to test personnel using applicable sections of the System Safety Verification Checklist in Appendix B.

a. The test item will be inspected as a system, and no disassembly of components or subsystems will be performed other than those specified as part of user-level maintenance.

b. Applicable system safety documents shall be reviewed to determine compliance to test and safety requirements. Safety documents include, but are not limited to: the Safety Assessment Report (SAR), Health Hazard Assessment Reports (HHARs), and Material Safety Data Sheets (MSDS). Use TOP 10-2-508[4] as guidance. The safety inspection will focus on obvious hazards to the operator.

5.3 Condensation Build-Up or Mitigation.

The purpose of this test is to determine how well a shelter can mitigate condensation issues through inherent material selection or design characteristics, or succumb to condensation build-up that would result in Warfighters and/or their equipment becoming wet during occupancy.

5.3.1 Setup and Test Procedure.

a. Erect the shelter system to be tested within the climatic chamber. Ensure that all guy lines and/or stakes are secured to the ground, and that all intended ventilation openings are configured as recommended by the manufacturer.

b. Instrument the shelter interior with four (4) temperature sensors (thermocouples, thermistors, etc.), placed as follows:

(1) Sensor number 1: placed central to the shelter at 1/3 the height from the ground to the shelter ceiling.

(2) Sensor number 2: placed central to the shelter at 2/3 the height from the ground to the shelter ceiling.

(3) Sensor number 3: placed central to the shelter, hung or supported by pole 6 inches from the ceiling.

(4) Sensor number 4: placed at 2/3 the height from the ground on the inside of the skin of the downwind shelter wall. The downwind shelter wall is the one not experiencing the wind normal to its wall surface. In other words, it is the shelter wall not facing the direction of the wind's origin.

c. Instrument the shelter interior with three (3) relative humidity sensors placed as follows:

(1) Sensor number 1: placed central to the shelter at 1/3 the height from the ground the shelter ceiling.

(2) Sensor number 2: placed central to the shelter at 2/3 the height from the ground the shelter ceiling.

(3) Sensor number 3: placed central to the shelter, hung or supported by pole 6 inches from the ceiling.

d. Establish connectivity between the data acquisition unit and temperature/humidity sensors. Configure the unit to scan and log the sensor data every sixty (60) seconds.

e. Bring the climatic chamber to 40 ºF and 80% RH. Allow the conditions to stabilize by waiting for temperature and humidity oscillations to stop. The guidelines for temperature and humidity are sufficient to provoke condensation, without unnecessarily overburdening the climatic chamber. Furthermore, more severe conditions have shown to negligibly provoke additional condensate to form.

f. Activate the recording function on the data acquisition unit, and ensure that data are being correctly recorded every sixty (60) seconds.

g. Place testing apparatus centrally within the shelter interior. Ensure that water reservoir is topped off and that power is connected.

h. Turn on the peristaltic dosing pump and allow it to prime. Priming is complete when no more air pockets are expelled from the tubing outlet.

i. Ensure that the peristaltic dosing pump is calibrated to flow at a rate of 20 milliliters per hour (ml/hr) of water per intended occupant of the shelter system to simulate the appropriate amount of water vapor exhaled during respiration. Use the below equation as a guideline:

$$\text{(size of shelter in number of occupants)} \times 20\ \text{mL/hr.} = \text{(flow rate of TOTAL water exhaled into shelter interior) mL/hr.} \qquad \text{Equation 1}$$

j. Turn on the heated water vaporization plate and allow it to warm up at “un-throttled” MAXIMUM power for five (5) minutes.

k. Ensure the heated water vaporization plate is at its maximum internal power setting to grant full range control of the heat output to the VARIAC. Begin to throttle the power going into the heated water vaporization plate with the VARIAC while watching the actual power consumption on the power meter. The equation below will indicate how much to throttle the heated water vaporization plate depending on the number of occupants the shelter system is intended for.

For a shelter of < 15-man:

$$\text{(size of shelter in number of occupants)} \times (40^{*}) = \text{(heated water vaporization plate output) Watts} \qquad \text{Equation 2}$$

* the constant of 40 was derived from calculations associated with heat required of the heated water vaporization plate to perform near instant vaporization of water given a certain flow rate of water introduction. This constant will allow for instant vaporization without overburdening the heated plate and potentially causing an unnecessarily hazardous condition.

l. The total power heating the shelter interior shall be 100 Watts per occupant. In the case of a 15-man shelter, the total heat will equal 1500 Watts of electrical resistance heating. After adjusting the VARIAC to throttle the hot plate’s heat output as indicated in the equation above, additional heat will be supplemented with small electrical resistance heaters. For example, when using additional heat in the form of multiple 200 Watt electrical resistance heaters:

(1) A 15-man shelter will require <u>four</u> 200 Watt (800 Watt total) electrical resistance heaters to be run throughout the test duration, to supplement the already 700 Watts provided by the heated plate.

(2) A 10-man shelter will require <u>two</u> 200 Watt (400 Watt total) electrical resistance heaters to be run throughout the test duration, to supplement the already 600 Watts provided by the heated plate.

(3) For shelter sizes not covered above, ensure that the TOTAL heat output matches the 100 Watt/occupant rule:

$$\text{(heated water vaporization plate output from Equation 2) Watts} + \text{(additional electrical resistance heaters output) Watts} = 100 \text{ Watts} * \text{(size of shelter in number of occupants)} \qquad \text{Equation 3}$$

m. Ensure that the peristaltic dosing pump is pumping the intended flow rate, the heated water vaporization plate is drawing the intended power, and the electrical resistance heaters are providing the intended amount of additional heat as determined by the shelter size.

n. Exit the shelter and close its entrance.

o. Make note of the start time, and allow the test to run for eight (8) uninterrupted hours.

p. In the case that shelter entry is necessary during test duration, ensure that the shelter door is left ajar for no more than one (1) minute.

5.3.2 <u>Evaluation of Condensation Results</u>.

a. Enter the shelter system and provide sufficient lighting to clearly see the interior shelter wall and floor fabric.

b. Using the scale in Table 3, and three (3) evaluators, have each individual record one score per shelter system. Each evaluator shall take notes of any localized condensation issues and severity thereof.

TABLE 3. EVALUATION SYSTEM

SCORE	CONDITION	DESCRIPTION
1	Dry	No change felt. Skin material feels completely dry, posing no threat to wetting sleeping bags or clothing.
2	Damp/Moist	Fabric feels moist and cool to touch, but no obvious amount of water is transferred to hand upon removing from shelter skin.
3	Wet	Fabric is clearly wet, and water is visible on hand after removing from shelter skin.
4	Visible drops	Condensate is clearly visible in the form of drops. These droplets may roll down the shelter skin and coalesce into larger drops.
5	Pooling	Small puddles or pools present on the floor. Clearly large build up of water within shelter interior.

NOTES: 1. A score of 1 will indicate successful mitigation of condensation that would otherwise wet sleeping bags or clothing.
2. A score of 2 indicates a generally successful mitigation of condensation but may still result in failure if in fact the moist area was localized on the sleeping surface of the shelter floor.
3. A score of 3-5 indicates a failure to mitigate condensation sufficiently.

5.4 Final Inspection.

a. Visually inspect the test item for previously unreported physical damages that may have occurred during testing.

b. Inventory major components.

c. Photograph and document any such damage.

6. TEST DATA REQUIRED.

6.1 Initial Inspection.

a. Background data of each item:

(1) Item nomenclature, model, serial number, manufacturer, etc.

(2) Inventory of major components. Use Table 2 if an Inventory List is not provided.

(3) Environmental test history of the test item. Has the test item been tested before?

b. Visually inspect the shipping package(s) and test item, and record the following:

(1) Any damage to the shipping package(s).

(2) Any damage to the test item or its accessory equipment including:

(a) Test item tears, broken accessories.

(b) Test item material deterioration.

(c) Manufacturing defects.

(d) Effects of moisture, spillage, mildew, or insect attack.

(e) Evidence of wear.

c. Shortages, such as:

(1) Missing accessories.

(2) Missing tools.

(3) Missing instructions.

(4) Missing components.

d. Photograph the following:

(1) Fully deployed shelter.

(2) Evidence of damage.

(3) Manufacturer’s labels and instructions (safety (cautions, warnings, lifting), operation, maintenance, etc.) attached to the test item.

6.2 Safety/Health.

Record data as described in TOP 10-2-508.

6.3 Condensation Build-up or Mitigation.

Record the following as applicable:

a. Date and time.

b. Shelter system evaluated.

c. Duration of test.

d. Description and photographs of any damage that may occur.

e. Instrumentation used.

f. Calibration dates of instrumentation.

g. Temperature within climatic chamber (temperature vs. time chart).

h. Relative humidity within climatic chamber (relative humidity vs. time chart).

i. Temperature data for sensors numbers 1-4 (temperature vs. time chart).

j. Relative humidity data for sensors numbers 1-3 (relative humidity vs. time chart).

k. Calculated dew point of shelter interior wall using the temperature read by sensor 4 and the percentage of interior relative humidity (RH).

6.4 Final Inspection.

Record the following as applicable:

a. Results of visual inspection.

b. Inventory of major test items.

c. Photographs of any damage.

d. Identify stage of corrosion (0-4) as per Army Regulation (AR) 750-59[5].

7. PRESENTATION OF DATA.

a. Summarize and evaluate data obtained for each performance characteristic for each test item. Use appropriate charts, tables, and graphs to summarize test data. Give special consideration to any condition or circumstance that may have contributed to any test result.

b. When applicable, compare data for each performance specification with customer requirements to determine if the requirements were met/not met. Summary of test data, requirements, and any other pertinent information should be documented in the final report.

APPENDIX A. ABBREVIATIONS.

ANSI	American National Standards Institute
AR	Army Regulation
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning
C	Celsius
DC	direct current
F	Fahrenheit
HHAR	Health Hazard Assessment Report
ID	inside diameter
ISO	International Organization for Standardization
MIL-STD	Military Standard
ml/hr	milliliters per hour
mph	miles per hour
MSDS	Material Safety Data Sheets
NCSL	National Conference of Standards Laboratories
NIST	National Institute of Standards and Technology
NVG	night vision goggles
PET	polyethylene terephthalate
RF	radio frequency
RH	relative humidity
rms	root mean square
SAR	Safety Assessment Report
TM	Technical Manual
TOP	Test Operations Procedure
US	United States
UV	ultraviolet
V	volt
W	watt

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APPENDIX B. SYSTEM SAFETY VERIFICATION CHECKLIST.

ELECTRICAL SAFETY			
ISSUE	YES	NO	NA
1. Are operating personnel protected from accidental contact with voltages in excess of 30 volts?			
2. Does each contact, terminal, or like device, having voltages between 70 and 500 volts, root mean square (rms) or direct current (DC), with respect to ground, have barriers or guards to minimize accidental contact by operating or maintenance personnel?			
3. Are barriers or guards that protect terminals or like devices exhibiting 70-500 volts, clearly marked to indicate highest voltage encountered upon its removal?			
4. Are portions of assemblies operating at potentials above 500 volts, rms or DC, completely enclosed from the remainder of the assembly, and is the enclosure provided with non-bypassable interlocks?			
5. Are enclosures for potentials, which exceed 500 volts, marked "DANGER, HIGH VOLTAGE, XXX VOLTS", in white on a red background?			
6. Do all circuits and capacitors discharge to 30 volts or less within more than two seconds after power is removed?			
7. If the answer to question 6 is No, are the high-voltage capacitors or circuits automatically discharged when the case or rack is opened?			
8. Are test points provided in equipment where measurement of potentials in excess of 300 volts is required?			
9. Are test points designed to require plug-in, not clamp-on, test instruments?			
10. Are green indicator lamps provided to indicate "power on"?			
11. Is sufficient space provided between shield endings and exposed conductors to prevent shorting or arcing?			
12. Are electrical conductors designed to prevent insertion of the wrong plug into a receptacle or any other mating unit?			
13. Are plugs and receptacles coded and marked to clearly indicate mating connectors where those of similar configuration are in close proximity?			
14. Are plugs and receptacles designed to preclude electrical shock and burns while being disconnected?			
15. Are male plugs de-energized when disconnected?			
16. Are dissimilar plug/receptacle pairs used in units containing explosives?			
17. When equipment is designed to operate on more than one type of input power, does the connector design prevent connection or use of improper power?			
18. Are single-phase power cables properly color coded: black: hot, white: neutral, green: ground?			
19. Are three-phase power cables coded as in Question 18, above, with the second and third phases in red and blue, respectively?			
20. Are meter terminals protected from voltages of 70 volts or more?			
21. Do probes that are part of or accessories to the equipment contain safety guards that prevent contact with the tip and is the length of the exposed portion of the tip not more than 0.75 inches? (This question does not apply if the voltages to be measured are less than (a) 30 volts rms, (b) 60 volts DC, or (c) 24.8 volts DC interrupted at a rate of 10 Hertz (Hz) to 200 Hz.)			

APPENDIX B. SYSTEM SAFETY VERIFICATION CHECKLIST.

ELECTRICAL SAFETY (CONT)			
ISSUE	YES	NO	NA
22. Are current and voltage overload protection devices provided?			
23. Except for antennas and transmission line terminals, are all external parts, surfaces, and shields at ground potential at all times?			
24. Is the path from the equipment to ground continuous and permanent?			
25. Is the ground wire color-coded green or green with yellow stripes?			
26. Does the ground have capacity to safely conduct any currents that might be imposed thereon?			
27. Is the ground wire separate from electrical circuits, i.e., not tied to neutral?			
28. Has a test been conducted to determine the amount of leakage current on the grounding conductor? If Yes, indicate the amount of current, in milliamperes, that was measured.			
29. Is the impedance of the path from the equipment tie point to ground sufficiently low to limit the potential drop and to allow the operation of overcurrent devices in the circuits?			
30. Does the path from the equipment tie point to ground have sufficient mechanical strength to minimize accidental ground disconnection?			
31. Is the ground connection to the chassis or frame secured by one of the following: spot welded terminal lug, soldering lug, screw, nut, and lockwasher?			
32. On transmitting equipment, is a grounding stud provided that permits attachment of a portable shorting rod?			
33. Except for radio frequency (RF) voltages, are antenna and transmission terminals at ground potential?			
34. Do convenience outlets automatically ground the mated plugs of metal-cased portable tools and equipment?			
35. Are both the phase and neutral supply voltage lines not connected to the chassis?			
36. Are wires and cables supported and terminated to prevent shock and fire?			
37. Are DC power connections color coded and marked for polarity?			
38. Does the main power switch cut off all power to the complete equipment?			
39. Is the main power switch clearly identified?			
40. Is the main power switch located on the front panel?			
41. Is physical protection provided from accidental contact with the power input side of the main power switch and the incoming power line connections?			
42. Are power switches located such that they cannot be operated by accidental contact?			
43. Are switches provided to deactivate mechanical drive units without disconnecting other parts of the equipment?			
44. Are means provided to cut off power while installing or replacing an item of equipment or an assembly or part thereof?			
45. Are emergency controls readily accessible and clearly identified?			
46. Does the equipment use batteries? If yes, indicate whether batteries are the primary or backup power source.			

APPENDIX B. SYSTEM SAFETY VERIFICATION CHECKLIST.

ELECTRICAL SAFETY (CONT)			
ISSUE	YES	NO	NA
47. Is the battery in the Government inventory? If yes, indicate the battery's nomenclature, e.g., BA-xxx, BB-xxx, etc.			
48. Can the battery enclosure or box prevent injury or damage in the event of a violent gas venting or rupture of the battery cells?			
49. Are battery compartments vented?			
MECHANICAL SAFETY HAZARD			
ISSUE	YES	NO	NA
1. Are safety covers provided for exposed gears, cams, levers, fans, and belts?			
2. Are self-locking or other fail-safe devices incorporated into expandable and collapsible structures, such as shelters, jacks, masts, and tripods, to prevent accidental or inadvertent collapsing or failing?			
3. Are positive means provided to prevent mis-mating of fittings; couplings; fuel, oil, hydraulic, and pneumatic lines; and mechanical linkages?			
4. Are doors and drawers and associated catches, hinges, supports, fasteners, and stops designed to prevent accidental injury?			
5. Is the installed equipment free of overhanging edges and corners that may cause injuries?			
6. Is the equipment likely to remain upright under normal use and in strong wind, considering its means of support and center of gravity?			
ENVIRONMENTAL SAFETY HAZARD			
ISSUE	YES	NO	NA
1. Is the temperature of all exposed parts less than 60 ºCelsius (C), when the ambient temperature is 25 ºC, regardless of the condition of operation?			
2. Is the temperature of front panels and operating controls less than 49 ºC, when the ambient temperature is 25 ºC, regardless of the condition of operation?			
3. Is the release of toxic, corrosive, or explosive fumes or vapors prevented?			
4. Are the outer coverings of cables, wires, and other components free of glass fiber materials?			
OTHER SAFETY HAZARD			
ISSUE	YES	NO	NA
1. Are there provisions to prevent injury from implosion of cathode ray tubes?			
2. Is equipment designed to prevent accidental ignition of hazardous atmospheres? (Applicable to equipment that is intended for use in atmospheres of explosive gas or vapors, combustible dusts, or ignitable fibers and flyings.)			
3. Is a shut-down device or an alarm provided to prevent injury or equipment damage?			
4. Is there adequate separation between critical warning lights and other lights?			
5. Are audible warning signals distinguishable from other sounds under normal operating conditions?			
6. Are warning circuits separate from control circuits?			
7. Is the display lighting of aircraft electronics (avionics) compatible with the use of night vision goggles (NVG)?			

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APPENDIX C. REFERENCES.

1. MIL-STD-810G, Department of Defense Test Method Standard, Environmental Engineering Considerations and Laboratory Tests, 31 October 2008.

2. ANSI/NCSL Z540.3, Requirements for the Calibration of Measuring and Test Equipment, 1 January 2006.

3. ISO 10012, Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment, 15 April 2003.

4. TOP 10-2-508, Safety and Health Hazard Evaluation - General Equipment, 6 May 1980.

5. AR 750-59, Army Corrosion Prevention and Control Program, 9 January 2006.

For information only (related publications).

a. American Society of Heating, Refrigeration and Air-Conditioning (ASHRAE) GRP 158, Load Calculation Manual (Cooling and Heating), p. 4.5, 1979.

b. Stine, H. G. Living in Space. M. Evans and Company, 1997.

c. Sydney Morning Herald. 4 August 2003. "Power from blood could lead to 'human batteries'". Internet. 29 August 2011. Available: http://www.smh.com.au/articles/2003/08/03/1059849278131.html.

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e. J B McCafferty, T. A.. "Effects of breathing pattern and inspired air conditions on breath condensate volume, pH, nitrite, and protein concentrations". Thorax, 2004.

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), US Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, MD 21005-5001. Technical information may be obtained from the preparing activity: US Army Aberdeen Test Center (TEDT-AT-WF-S), 400 Colleran Road, Aberdeen Proving Ground, MD 21005-5055. Additional copies can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.